CHAPTER 2

COMPELLING RATIONALES FOR SPACEFLIGHT? HISTORY AND THE SEARCH FOR RELEVANCE

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Are there compelling reasons to travel into space? Assuming that there are, when did they emerge in the consciousness of the space community, opinion leaders, politicos, larger public? How have those compelling reasons for spaceflight been articulated and adjusted over time? With all of the changes in the larger society during the last half century, do those rationales remain persuasive at the dawn of the 21st century? Finding answers to these questions are probably *the* most critical issues currently facing the space policy community. Of course, these issues may be considered without the use of historical analysis, and many do so, but the debate is immeasurably enriched by an understanding and explication of the historical evolution of the rationales that have been offered for why humanity seeks to fly in space. This essay begins with a discussion of the motivations for spaceflight—ultimately resting on the deep-seated desire to become a multiplanetary species and a quest for utopia beyond this realm—before moving into a sustained discussion of the five rationales for spaceflight that have been advanced over time: national pride/prestige/geopolitics, human destiny/survival of the species, commercial and other applications, national security, and science and technology. All of these have been used over time to support the concept of spaceflight. But are they compelling rationales today? Were they ever? The conclusion of this essay explores the long-term consequences of these rationales.

A QUESTION OF MOTIVATION

Of course, one must ask the question, why did spaceflight advocates believe so thoroughly in the necessity of moving beyond "Mother Earth?" Certainly, they viewed it as a thrilling adventure, one that would test the best that humanity had to offer. Was it simply a problem to be solved, or did they envision something more? Ultimately, what was the point of sending people into space? Is not the expansion of a human presence throughout the cosmos the real, long-term agenda? I am convinced that there was much more to it than just trying to solve an engineering problem, although few of the spaceflight enthusiasts systematically expressed their long-term objectives. In

essence, the advocates have long believed that it is human destiny to become a multiplanetary species, not just as an end in itself, but because of the desire to create a utopian society free from the constraints of cultures on Earth.

De Witt Douglas Kilgore has recently noted that this motivation may be characterized as "astrofuturism," the application in the American tradition of technological utopianism responding to the political upheavals of the 20th century. Kilgore asserts that the pro-space utopian impulse was founded in the imperial politics and utopian schemes of the 19th century but envisions outer space as an endless frontier that offers solutions to the economic and political problems that dominate the modern world. Its advocates used the conventions of technological and scientific conquest to express the ideals and contradictions endemic to American culture. Astrofuturists, according to Kilgore, imagined space frontiers that could extend the reach of the human species and heal its historical wounds. Their efforts both replicated dominant social presuppositions and supplied the technologies necessary for the critical utopian projects that emerged in the latter 20th century.[1]

One critical astrofuturist, the American rocket pioneer Robert H. Goddard, wrote effectively about breaking the bonds of Earth to achieve the full potential of the human spirit. A native of Worcester, Massachusetts, Goddard had a surprisingly metaphysical perspective on the cause of human spaceflight. As a boy, while his family was staying at the suburban home of friends in Worcester on 19 October 1899, he climbed into an old cherry tree to prune its dead branches. Instead, he began daydreaming. As he wrote later, "It was one of the quiet, colorful afternoons of sheer beauty which we have in October in New England, and as I looked toward the fields at the east, I imagined how wonderful it would be to make some device which had even the possibility of ascending to Mars, and how it would look on a small scale, if sent up from the meadow at my feet." From that point on, Goddard enthusiastically pursued the idea of spaceflight as a necessary part of human destiny. He wrote in his diary, "Existence at last seemed very purposive." In addition, 19 October became "Anniversary Day," noted in his diary as his personal holiday. He went on to tie space exploration to a surprisingly utopian vision of the future. At his high school oration in 1904, he summarized his life's perspective: "It is difficult to say what is impossible, for the dream of yesterday is the hope of today and the reality of tomorrow."[2] Later he added, "Every vision is a joke, until the first man accomplishes it."

1. See De Witt Douglas Kilgore, *Astrofuturism: Science, Race, and Visions of Utopia in Space* (Philadelphia: University of Pennsylvania Press, 2003).

2. Two solid biographies of Goddard are Milton Lehman, *This High Man: The Life of Robert H. Goddard* (New York: Farrar, Straus, 1963), which is outdated, and David A. Clary, *Rocket Man: Robert H. Goddard and the Birth of the Space Age* (New York: Hyperion, 2003). The quotations are from Esther C. Goddard, ed., and G. Edward Pendray, assoc. ed., *The Papers of Robert H. Goddard*, 3 vols. (New York: McGraw-Hill Book Co., 1970), 1:10, 1:63–66.

The most powerful justification Goddard ever offered for humanity's movement into space was an essay called "The Great Migration," written on 14 January 1918 but not made public until much later. He scrawled across the envelope: "To be given to the Smithsonian Institution, after the owner has finished with it, there to be preserved on file, and used at the discretion of the Institution. The notes should be read thoroughly only by an optimist." In this essay, Goddard postulated a time in the distant future when the Sun had cooled and life on Earth could no longer be sustained. He envisioned gigantic, intergalactic arks taking the essence of the creatures and knowledge of this planet to new homes throughout the vastness of the Milky Way. "It has long been known," he wrote, "that protoplasm can remain inanimate for great periods of time, and can also withstand great cold, if in the granular state." There, amidst the stars, human society would replicate the best of what it had to offer.[3] While the issue of utopianism is implicit, it is still present and offered for Goddard a reason to dedicate his life to building the technology necessary to achieve multiplanetary migration.

These ideas of human destiny and perfect societies on new and perfect worlds have been expanded upon and extended far beyond Goddard's basic vision in numerous subsequent works. Wernher von Braun, the single most important promoter of America's space effort in the 1950s and 1960s, captured the essence of American utopian idealism and used it to justify an aggressive space exploration program.[4] Although a German immigrant to the United States after World War II, or perhaps because of it, he was remarkable in his grasp of what made Americans tick. He spoke often of "The Challenge of the Century" as a continuation of American exploration and settlement and the creation of a perfect society in a new land. "For more than 400 years the history of this nation has been crammed with adventure and excitement and marked by expansion," he said. "Compared with Europe, Africa, and Asia, America was the New World. Its pioneer settlers were daring, energetic, and self-reliant. They were challenged by the promise of unexplored and unsettled territory, and stimulated by the urge to conquer these vast new frontiers." Americans need the space frontier both physically and spiritually, von Braun insisted, and suggested that greater efforts in moving beyond the Earth would lead to a society in which "right relationships" prevailed.[5]

3. Robert H. Goddard, "The Great Migration," in *Papers of Robert H. Goddard*, ed. Goddard and Pendray, 3:1611–1612.

4. It is important to understand that this effort to colonize the cosmos was not limited to Goddard. Hermann Oberth wrote, "This is the goal: To make available for life every place where life is possible. To make inhabitable all worlds as yet uninhabitable, and all life purposeful" (Hermann Oberth, *Man into Space* [New York: Harper and Brothers, 1957], p. 167).

5. Wernher von Braun, "The Challenge of the Century," 3 April 1965, Wernher von Braun Biographical File, NASA Historical Reference Collection, Washington, DC.

Von Braun never wavered in his commitment to creating a perfect society in space. In a 1976 speech to the National Space Institute, he pointed to a bright future for humanity if it embarked on the high frontier of space. He said space would "offer new places to live—a chance to organize a new interplanetary society, and make fresh beginnings."[6] He believed this was "as inevitable as the rising of the sun; man has already poked his nose into space and he is not likely to pull it back . . . . There can be no thought of finishing, for aiming at the stars—both literally and figuratively—is the work of generations, and no matter how much progress one makes, there is always the thrill of just beginning."[7]

Gerard K. O'Neill, an experimental physicist at Princeton University, emerged during the 1970s to emphasize the possibilities of human settlement in space colonies. He left an indelible mark on the utopia-in-space movement by advocating the development of gigantic cylinders or spheres of roughly one-half by a few miles in size that would hold a breathable atmosphere, all the ingredients necessary for sustaining crops and life, and include rotating habitats to provide artificial gravity for thousands of inhabitants. While the human race might eventually build millions of these space colonies, each settlement would of necessity be an independent biosphere. Animals and plants endangered on Earth would thrive on these cosmic arks; insect pests would be left behind. Solar power, directed into each colony by huge mirrors, would provide a constant source of nonpolluting energy. Positioned at a specific point between the Earth and the Moon where the gravitation fields are equalized, known as LaGrange Point 5 (L-5), these O'Neill colonies could pursue the perfect society absent the problems of the parent society.[8]

This bold vision catapulted O'Neill into the spotlight of the space community and prompted a collective swoon from the thousands attracted to his ideas. They formed the L-5 Society in 1975 and adopted the slogan "L-5 in 1995." A particularly attractive group of space activists, one of their members wittily opined that they intended to "disband the Society in a mass meeting at L-5."[9] The space settlement mission also received a major boost from numerous science fiction and science fact writers, among them Arthur

6. "For Space Buffs—National Space Institute, You Can Join," *Popular Science* (May 1976): 73.

7. Wernher von Braun, "Crossing the Last Frontier," *Collier's* (22 March 1952): 24–29, 72–73. See also Ernst Stuhlinger and Frederick I. Ordway III, *Wernher von Braun, Crusader for Space: A Biographical Memoir* (Malabar, FL: Robert E. Krieger Company, 1994).

8. Gerard K. O'Neill, "The Colonization of Space," *Physics Today* 27 (September 1974): 32–40; Gerard K. O'Neill, *The High Frontier: Human Colonies in Space* (New York: William Morrow, 1976); Peter E. Glaser, "Energy from the Sun—Its Future," *Science* 162 (1968): 857–860; Peter E. Glaser, "Solar Power via Satellite," *Astronautics & Aeronautics* (August 1973): 60–68; Peter E. Glaser, "An Orbiting Solar Power Station," *Sky and Telescope* (April 1975): 224–228.

9. Michael A. G. Michaud, *Reaching for the High Frontier: The American Pro-Space Movement, 1972–84* (New York: Praeger, 1986), pp. 57–102.

C. Clarke, who popularized O'Neill's concept for colonies in space.[10] The strongly utopian impulse present in the O'Neill movement found voice in the words of aerospace writer T. A. Heppenheimer. "On Earth it is difficult for . . . people to form new nations or region[s] for themselves. But in space it will become easy for ethnic or religious groups, and for many others as well to set up their own colonies," Heppenheimer wrote. "Those who wish to found experimental communities, to try new social forms and practices, will have the opportunity to strike out into the wilderness and establish their ideals in cities in space."[11]

O'Neill's vision of practical and profitable colonies in space found an audience in many quarters of NASA even as it did in the larger pro-space movement. He received funding from NASA's Advanced Programs Office—but only $25,000—to develop his ideas more fully. Senior NASA officials such as Administrator James C. Fletcher and Ames Research Center Director Hans Mark encouraged his efforts. At the same time, some discredited his vision of colonies in space as hopelessly utopian.[12]

In the summer of 1975, NASA officials took O'Neill's ideas seriously enough to convene a study group of scientists, engineers, economists, and sociologists at the Ames Research Center, near San Francisco, to review the idea of space colonization, and followed it up with a study the next summer. Surprisingly, they found enough in the scheme to recommend it. Although budget estimates of $100 billion in then-year dollars accompanied the colonization project, the authors of this study concluded, "in contrast to Apollo, it appears that space colonization may be a paying proposition." For them, it offered "a way out from the sense of closure and of limits which is now oppressive to many people on Earth." The study recommended an international project led by the United States that would result in the establishment of a space colony at L-5. Most importantly, and decidedly utopian in expression, the study concluded:

> The possibility of cooperation among nations, in an enterprise which can yield new wealth for all rather than a conflict over the remaining resources of the Earth, may be far more important in the long run than the immediate return of energy to the Earth. So, too, may be the sense of hope and of

10. Arthur C. Clarke, *Rendezvous with Rama* (New York: Bantam Books, 1973).

11. T. A. Heppenheimer, *Colonies in Space* (Harrisburg, PA: Stackpole Books, 1977), pp. 279–280.

12. This would be completely consistent with their ideology. See Roger D. Launius, "A Western Mormon in Washington, D.C.: James C. Fletcher, NASA, and the Final Frontier," *Pacific Historical Review* 64 (May 1995): 217–241; Hans Mark, *The Space Station: A Personal Journey* (Durham, NC: Duke University Press, 1987); "Colonies in Space," *Newsweek* (27 November 1978): 95–101.

> new options and opportunities which space colonization can bring to a world which has lost its frontiers.[13]

O'Neill publicized these findings exhaustively, but with political will for an aggressive space effort at low tide in the latter 1970s, nothing came of it.[14]

The utopian impulse has been strong in the history of the pro-space community since that time and has manifested itself in numerous quarters and by various advocates. The libertarian viewpoint of Rick Tumlinson and the Space Frontier Foundation clearly evokes a utopian mindset.[15] The commitment of Lyndon LaRouche to space colonization also bespeaks a utopian vision for the future modeled on his unique political and social ideals.[16] At some level, the rise of a conservative space agenda in the last two decades of the 20th century represented a utopian impulse as well, oriented as it is toward a celebration of the ideology of progress. The placement of the history of the Strategic Defense Initiative/"single stage to orbit" (SSTO)/space colonization effort in the context of the United States' well-documented political "right turn" may represent the central thrust of space policy since the 1980s. The foundation and growth of this conservative space policy agenda has been well-documented in several historical works. Its linkage to various space advocacy groups, conservative futurists such as Gerry Pournelle, and space-power advocates such as Pete Worden ensured that conservative space advocates were able to manipulate the political system to achieve funding for their technological goals. At sum, they were intent on remaking both this world and outer space into a utopia of their own design.[17]

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13. Richard D. Johnson and Charles Holbrow, eds., *Space Settlements: A Design Study in Colonization* (Washington, DC: NASA SP-413, 1977), pp. 27–28, a study sponsored by NASA Ames, American Society for Electrical Engineering (ASEE), and Stanford University in the summer of 1975 to look at all aspects of sustained life in space. See also John Billingham, William Gilbreath, Gerard K. O'Neill, and Brian O'Leary, eds., *Space Resources and Space Settlements* (Washington, DC: NASA SP-428, 1979).

14. The latter half of the 1970s might best be viewed as a nadir in human space exploration, with the Apollo program gone and the Shuttle not yet flying. See Louis J. Halle, "A Hopeful Future for Mankind," *Foreign Affairs* 59 (summer 1980): 1129–1136.

15. See Rick N. Tumlinson, "Why Space? Personal Freedom," Message 6 of the Frontier Files, 1995, *http://www.space-frontier.org/frontierfiles.html* (accessed 11 April 2001); Rick N. Tumlinson, "The Foundation Credo—Our View of the Frontier," Part 4 of 4, Frontier Files, 1995, *http://www.space-frontier.org/frontierfiles.html* (accessed 11 April 2001).

16. See Lyndon H. LaRouche, *The LaRouche-Bevel Program to Save the Nation: Reversing 30 Years of Post-Industrial Suicide* (Leesburg, VA: Independents for Economic Recovery, 1992). See especially chap. 11, "Frontier in Space," pp. 88–100.

17. This subject has been discussed in Andrew J. Butrica, *Single Stage to Orbit: Politics, Space Technology, and the Quest for Reusable Rocketry* (Baltimore, MD: Johns Hopkins, 2003), and W. D. Kay, "Space Policy Redefined: The Reagan Administration and the Commercialization of Space," *Business and Economic History* 27 (fall 1998): 237–247.

While the quest for utopia in space has been implicit rather than explicit, there has never been any question but that the long-term objective of spaceflight is human colonization of the cosmos. Virtually all models for the future of spaceflight have at their core human expansion beyond Earth. This model for human colonization of the cosmos was first developed in the 1950s, honed to a fine edge in later years, and carried to its logical conclusion by many in the more recent past. Promises in space of a bountiful future, in which all have enough resources to live a rewarding life, where there is unlimited economic potential, where peace and justice reign for all, and where the perfectibility of humankind is expected are all utopian sentiments. In addition, allusions to spaceflight as an attribute of human destiny and the hearkening back to a positive American frontier experience also stimulate visions of idyllic, perfect places.[18]

There is also a basic belief, utopian at its base, that spaceflight offers the only hope for the continuation of the human race. Asteroids or nuclear holocaust or environmental degradation or even a supernova all spell eventual doom for this planet and all who reside here. Astronaut John Young—veteran of Gemini, Apollo, and Space Shuttle missions—believes that the truly endangered species on Earth are humans. The only way to escape is to leave. The idea of a series of arks containing the living creatures of Earth is especially appealing since Americans so often conceptualize of themselves as called apart to "redeem" the world. Time is short, and every day brings humankind closer to destruction.[19]

Because of spaceflight's critical role in human colonization beyond Earth, it was logical that the early enthusiasts would always envision space exploration with humans at the center. For them, it made no sense to send robots as surrogates. We had to go ourselves because our ultimate purpose was to move outward. And, of course, humans did so with resounding success, landing on the Moon only 12 years after the launch of the first Earth-orbital satellite. Having reached the conclusion that human destiny requires movement outward from Earth and colonization of the solar system and, ultimately, the cosmos, the next question revolves around how it is advocated before the larger public. What rationales have been advanced in support of the grand design of human spaceflight? How effective have they been in garnering support for this great adventure?

18. While I do not want to overstate this case, I believe it is a very real aspect of the current spaceflight agenda of a cadre of "true believers." I have emphasized this part of the story in the period since the 1970s in "Perfect Worlds, Perfect Societies: The Persistent Goal of Utopia in Human Spaceflight," *Journal of the British Interplanetary Society* 56 (September/October 2003): 338–349.

19. John W. Young to Steve Hawley et al., "Why the Human Exploration of the Moon and Mars Must Be Accelerated," 9 March 2001, John Young File, folder 18552, NASA Historical Reference Collection, Washington, DC.

FIVE RATIONALES FOR SPACEFLIGHT

From the defining event of Sputnik in 1957, five major themes have been used to justify a large-scale space exploration agenda. None of them explicitly advocate the human colonization of space—although that theme is implicit throughout—and none even hint at the larger utopian objective, despite its fundamental presence within the spaceflight community. The five themes are as follows:

1) Human destiny/survival of the species.
2) Geopolitics/national pride and prestige.
3) National security and military applications.
4) Economic competitiveness and satellite applications.
5) Scientific discovery and understanding.

Those themes have continued to motivate American space policy from the very beginning of the Space Age to the present. Specific aspects of these five rationales have fluctuated over time but remain the primary reasons for the endeavor. Indeed, there are no more nor no less than these five basic rationales.

Human Destiny/Survival of the Species

The first and most common rationale for spaceflight is that an integral part of human nature is a desire for discovery and understanding. In essence, it is human destiny to explore, to learn, and to absorb new knowledge and new territories into the human experience. With the Earth so well known, space exploration advocates argue, exploration and settlement of the Moon and Mars is the next logical step in human exploration. Humans must question and explore and discover or die, advocates for this position insist. It is the "final frontier," and Americans have always responded well to their frontiers.

When speaking and writing of these possibilities, many space advocates explicitly use the language of the "Frontier Thesis," described for America in Frederick Jackson Turner's famous 1893 essay. Turner's "Frontier Thesis" is perhaps the most influential essay ever read at the American Historical Association's annual conference. It has exerted a powerful force in the historiography of the United States, in no small measure because of its powerful statement of American exceptionalism and its justification of conquest. Turner took as his cue an observation in the 1890 U.S. census that the American frontier had, for the first time, closed. He noted, "Up to our own day American history has been in a large degree the history of the colonization of the Great West. The existence of an area of free land, its continuous recession, and the advance of American settlement westward explain American development." He insisted that the frontier made Americans American, gave the nation its

democratic character, and ensured the virtues of self-reliance, community, and the promise of justice. He noted that cheap or even free land provided a "safety valve" that protected the nation against uprisings of the poverty-stricken and malcontented. The frontier also produced a people with "coarseness and strength . . . acuteness and inquisitiveness, that practical and inventive turn of mind . . . [full of] restless and nervous energy . . . that buoyancy and exuberance which comes with freedom." It gave the people of the United States, in essence, virtually every positive quality they have ever possessed.[20]

Repeated use of the frontier analogy for spaceflight, with its vision of a new land and a new and better society, has given the American public a distinctive perspective on spacefaring. It always tapped a vein of rich ideological power. The symbolism of the frontier has been critical to understanding how Americans have viewed themselves since at least the end of the 19th century, and perhaps much longer. It conjured up an image of self-reliant Americans moving westward in sweeping waves of discovery, exploration, conquest, and settlement of an untamed wilderness. And in the process of movement, the Europeans who settled North America became an indigenous American people. The frontier concept has always carried with it the ideals of optimism, democracy, and right relationships.

It also summoned in the popular mind a wide range of vivid and memorable tales of heroism, each a morally justified step toward the modern democratic state. While the frontier ideal reduced the complexity of events to a relatively static morality play, avoided matters that challenged or contradicted the myth, viewed Americans moving westward as inherently good and their opponents as evil, and ignored the cultural context of westward migration, it served a critical unifying purpose for spaceflight advocates. Those persuaded by this metaphor (and many have been) recognize that it summons them not only to recall past glories, but also to undertake—or at least to acquiesce in—a heroic engagement under the ideal with the forces of social, political, and economic injustice.[21]

Turner's image of the American frontier has been an especially evocative and somewhat romantic popular theme for proponents of an aggressive space program. The popular conception of "westering" and the settlement of the American continent by Europeans has been a powerful metaphor for the propriety of space exploration and has enjoyed wide usage by supporters of space exploration. It hearkens back to the American West and the frontier in speaking of what might be gained in the unknown of space. But more important, it calls

20. Frederick Jackson Turner, "The Significance of the Frontier in American History," *The Frontier in American History* (New York: Holt, Rinehart, and Winston, 1920), pp. 1–38.

21. See Richard Slotkin, *Gunfighter Nation: The Myth of the Frontier in Twentieth-Century America* (New York: Atheneum, 1992).

upon the adventurousness of the American people and offers the promise of a utopian change in society as it moves to a new, untainted place where it could remake society. Such has always been the siren call of the frontier myth.

From Captain James T. Kirk's soliloquy—"Space, the final frontier"—at the beginning of each *Star Trek* episode to President John F. Kennedy's 1962 speech about setting sail on "this new ocean" of space, the exploration and colonization allusion has been a critical component of space program promotion. Astronaut, then Senator, John Glenn captured some of this tenor in 1983 when he summoned images of the American heritage of pioneering and argued that the next great frontier challenge was in space. "It represents the modern frontier for national adventure. Our spirit as a nation is reflected in our willingness to explore the unknown for the benefit of all humanity, and space is a prime medium in which to test our mettle."[22]

Quintessential American novelist James A. Michener also applied this frontier analogy to the space program. In two articles in *Omni* magazine in the early 1980s, he explicitly compared the space program to the Anglo-American westward movement of the 19th century. He described the American sense of pioneering and argued that the next great challenge in this arena is space. "A nation that loses its forward thrust is in danger," he commented; "the way to retain it is exploration." In an eloquent and moving way, he argued for the American space program as the logical means of carrying out exploration. One of these articles had the ironic title of "Manifest Destiny," a blatant hearkening to the ideology of continental expansion that gained preeminence in the 1840s. Michener argued that it is the American destiny to explore and colonize, and space is the next logical place to do this. His statement presents an eloquent and moving defense of America's human space program in all its permutations.[23]

NASA Administrator for nine years in the 1970s and 1980s, James C. Fletcher was especially attracted by the analogy of the American frontier. A Caltech Ph.D., he guided NASA during the critical period of redefining the space program at the conclusion of Apollo and for three years after the *Challenger* accident. But for all his hardheaded practicality, for all his understanding of science, he was enthralled with the frontier allusion and made specific connections to his pioneering ancestors in Utah. He commented:

> History teaches us that the process of pushing back frontiers on Earth begins with exploration and discovery and is followed by

22. John Glenn, Jr., "The Next 25: Agenda for the U.S.," *IEEE Spectrum* (September 1983): 91.

23. James A. Michener, "Looking toward Space," *Omni* (May 1980): 58. See also James A. Michener, "Manifest Destiny," *Omni* (April 1981): 48–50, 102–104.

> permanent settlements and economic development. Space will be no different . . . . Americans have always moved toward new frontiers because we are, above all, a nation of pioneers with an insatiable urge to know the unknown. Space is no exception to that pioneering spirit.[24]

The frontier myth's accessibility, coming with its utopian imagery, has served the pro-space movement well. Casting decisions on projects as facilitating the opening of this frontier has enormous appeal and has been used repeatedly since the launch of Sputnik.

But invoking Frederick Jackson Turner has become increasingly counterproductive for anyone who appreciates postmodern multicultural society. Historians appropriately criticize Turner's approach as excessively ethnocentric, nationalistic, and somewhat jingoistic. His rhetoric excludes more than it covers, failing to do justice to diverse western people and events. Yale historian Howard R. Lamar believes the Frontier Thesis emphasizes an inappropriate discontinuity between a mythical rural past and an urban-industrial future. Thus, it is unsuitable as a guide for understanding the present or projecting the future. Some scholars also discount its central safety-valve proposition. It may have applied in antebellum America, when many did "go West," they suggest, but failed to hold after the Civil War as the prospect of migration moved beyond the reach of urban slumdwellers and others because of a lack of funds for farming and transportation. In fact, later settlers, mostly the children of farmers, arrived from the fringes of existing settlements. Despite the criticism, the Frontier Thesis has had lasting appeal, in no small measure because it tells Americans how perfect they could become and offers an easily understandable if simplistic explanation for why that is the case. It is a small wonder that the Frontier Thesis would find service among those advocating an aggressive space exploration program![25]

President George W. Bush also supported space exploration as a human-destiny program in his 14 January 2004 announcement of a new vision for NASA. He stated that NASA would return to the Moon and eventually send astronauts to Mars. Doing so, as stated in the White House release on this subject, was human destiny:

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24. James C. Fletcher, "Our Space Program Is Already Back on Track," *USA Today* (28 July 1987); R. Scott Lloyd, "NASA Head Is Veteran Teacher," *Salt Lake City (UT) Church News* (25 May 1986).

25. See John Mack Faragher, *Rereading Frederick Jackson Turner: The Significance of the Frontier in American History, and Other Essays* (New York: Henry Holt, 1994); Allan G. Bogue, *Frederick Jackson Turner: Strange Roads Going Down* (Norman: University of Oklahoma Press, 1998); Ray Allen Billington, *America's Frontier Heritage* (Albuquerque: University of New Mexico Press, 1974).

> America's history is built on a desire to open new frontiers and to seek new discoveries. Exploration, like investments in other Federal science and technology activities, is an investment in our future. President Bush is committed to a long-term space exploration program benefiting not only scientific research, but also the lives of all Americans. The exploration vision also has the potential to drive innovation, development, and advancement in the aerospace and other high-technology industries.[26]

In explicitly raising the issue of the space frontier, the President followed a long succession of advocates who invoked the happy metaphor of America's westward expansion to support his idea of human destiny.

If human destiny is a positive attribute that generally finds resonance among spaceflight advocates and the general public, there is also a terrifying aspect to this rationale. The flip side of the human-destiny argument is that humanity will not survive if it does not become multiplanetary. Carl Sagan wrote eloquently about the last perfect day on Earth, before the Sun would fundamentally change and end our ability to survive on this planet.[27] In their astrobiology book, *The Life and Death of Planet Earth*, Peter Ward and Donald Brownlee describe the natural life cycle of stars such as our Sun and the planets that circle them. They describe several possible scenarios for the end of life on Earth. Life on Earth will definitely end when the Sun, having used up too much of its hydrogen will become a red giant star and heat the Earth until every living thing, no matter how deep underground, is dead.[28]

While this will happen billions of years in the future, any number of catastrophes could end life on Earth beforehand. A much earlier and quite likely way for life (or at least life as we know it) to end is the way life almost ended 65 million years ago when either an asteroid or a comet crashed into the Earth. The consequences of this collision caused the extinction of the dinosaurs and probably two-thirds of all life on Earth at that time. Enough life survived the harsh environmental aftermath and gave rise to mammals, a highly adaptable species that even survived the last Ice Age.

In 1992, a noted scientist spoke to the American Astronautical Society on the subject "Chicken Little Was Right." The scientist claimed that humans had a greater chance of being killed by a comet or asteroid falling from the sky than dying in an airplane crash. This is true; mathematical calculations confirm

26. White House Press Release, "President Bush Announces New Vision for Space Exploration Program," 14 January 2004, *http://www.whitehouse.gov/infocus/space/#* (accessed 30 December 2004).

27. Carl Sagan, *Cosmos* (New York: Random House, 1980), pp. 231–232.

28. See Peter D. Ward and Donald Brownlee, *The Life and Death of Planet Earth: How the New Science of Astrobiology Charts the Ultimate Fate of Our World* (New York: Henry Holt and Co., 2002).

that every individual faces a 1-in-5,000 chance of being killed by some type of extraterrestrial impact. Throughout history, asteroids and comets have struck Earth, and a great galactic asteroid probably killed the dinosaurs. An object probably only 6 to 9 miles wide left a crater 186 miles wide in Mexico's Yucatan Peninsula. This reality entered most people's consciousness in July 1994, when humans for the first time witnessed the devastating impact of a large Near-Earth Object (NEO) into one of the planets in the solar system when Comet Shoemaker-Levy 9 crashed into Jupiter with spectacular results.[29]

With time, a comet or meteoroid will again hit Earth with disastrous consequences. Efforts to catalogue all Earth-crossing asteroids, track their trajectories, and develop countermeasures to destroy or deflect objects on a collision course with Earth are important, but to ensure the survival of the species, humanity must build outposts elsewhere. Astronaut John Young said it best, to paraphrase Pogo, "I have met an endangered species, and it is us."[30]

Geopolitics/National Pride and Prestige

In addition, geopolitics and national prestige have dominated so many of the spaceflight decisions that it sometimes seems trite to suggest that it has been an impressive rationale over the years. Yet there is more to it than that, for while all recognize that prestige sparked and sustained the space race of the 1960s, they fail to recognize that it continues to motivate many politicians to support NASA's programs. John F. Kennedy responded to the challenge of the Soviet Union by announcing the Apollo decision in 1961, and that rivalry sustained the effort. Kennedy put the world on notice that the U.S. would not take a back seat to its superpower rival. As John M. Logsdon commented, "By entering the race with such a visible and dramatic commitment, the United States effectively undercut Soviet space spectaculars without doing much except announcing its intention to join the contest."[31] Kennedy said in 1962 that "we mean to be a part of it [spaceflight]—we mean to lead it. For the eyes of the world now look into space, to the moon and to the planets beyond, and we have vowed that we shall

29. K. Zahnle and M. M. Mac Low, "The Collision of Jupiter and Comet Shoemaker-Levy 9," *Icarus* 108 (1994): 1–17; Paul W. Chodas and Donald K. Yeomans, "The Orbital Motion and Impact Circumstances of Comet Shoemaker-Levy 9," in *International Astronomical Union (IAU) Colloquium 156: Proceedings of the Space Telescope Science Institute Workshop* (held in Baltimore, MD, 9–12 May 1995), ed. Keith S. Noll, Harold A. Weaver, and Paul D. Feldman (New York: Cambridge University Press, 1996), pp. 1–30. On the mass extinction of the dinosaurs, see Walter Alvarez, *T. Rex and the Crater of Doom* (Princeton, NJ: Princeton University Press, 1997).

30. John W. Young, "The Big Picture: Ways to Mitigate or Prevent Very Bad Planet Earth Events," *Space Times: Magazine of the American Astronautical Society* 42 (November/December 2003): 22–23.

31. John M. Logsdon, "An Apollo Perspective," *Astronautics & Aeronautics* (December 1979): 112–117, quotation from p. 115. See also John M. Logsdon, *The Decision to Go to the Moon: Project Apollo and the National Interest* (Cambridge, MA: Massachusetts Institute of Technology [MIT] Press, 1970).

not see it governed by a hostile flag of conquest, but by a banner of freedom and peace. We have vowed that we shall not see space filled with weapons of mass destruction, but with instruments of knowledge and understanding."[32] Apollo was a contest of wills, of political systems, of superpowers. And the United States had to win it. Lyndon Johnson summed this up well with his assertion, "Failure to master space means being second best in every aspect, in the crucial area of our Cold War world. In the eyes of the world first in space means first, period; second in space is second in everything."[33]

Through the decade of the 1960s, prestige dominated much of the discussion of Apollo, even penetrating to the popular culture. Actor Carroll O'Connor perhaps said it best in an episode of *All in the Family* in 1971. Portraying the character of Archie Bunker, the bigoted working-class American whose perspectives were more common in our society than many observers were comfortable with, O'Connor summarized well how most Americans responded to the culture of competence that Apollo engendered. He observed that he had "a genuine facsimile of the Apollo 14 insignia. That's the thing that sets the US of A apart from . . . all them other losers."[34] In very specific terms, Archie Bunker encapsulated for everyone what set the United States apart from every other nation in the world: success in spaceflight. At a basic level, Apollo provided the impetus for the perception of NASA as a culture of competence, one of the great myths emerging from the lunar landing program.

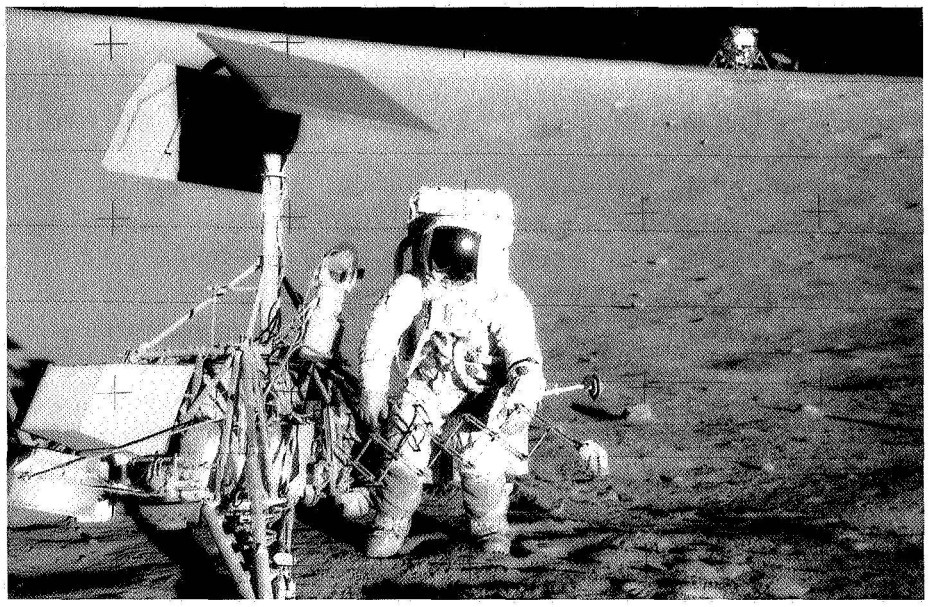
The United States went to Moon for prestige purposes, but it also built the Space Shuttle and embarked on the space station for prestige purposes as well. The turning point for Richard Nixon's decision to proceed with the Space Shuttle for post-Apollo spaceflight came in August 1971 when Caspar Weinberger wrote an impassioned memorandum to the President that not to do so "would be confirming in some respects, a belief that I fear is gaining credence at home and abroad: That our best years are behind us, that we are turning inward, reducing our defense commitments, and voluntarily starting to give up our super-power status, and our desire to maintain world superiority." Weinberger appealed directly to the prestige argument by concluding, "America should be able to afford something besides increased welfare, programs to repair our cities, or Appalachian relief and the like." In a handwritten scrawl on

32. President John F. Kennedy, "Address at Rice University on the Nation's Space Effort," 12 September 1962, Houston, TX, John Fitzgerald Kennedy Library, Boston, MA, available online at *http://www.cs.umb.edu/jfklibrary/j091262.htm* (accessed 27 October 2002).

33. Lyndon B. Johnson, quoted in Walter A. McDougall, "Technocracy and Statecraft in the Space Age: Toward the History of a Saltation," *American Historical Review* 87 (October 1982): 1010–1040, quotation from p. 1025.

34. "Carroll O'Connor Obituary," on *Morning Edition* (National Public Radio program), 22 June 2001. This report by Andy Bowers is available online at *http://www.npr.org* (accessed 2 July 2001).

Weinberger's memo, Richard Nixon indicated, "I agree with Cap."[35] Prestige also entered into the decision in one other way. Nixon was also unwilling to go down in history as the President who gave away the nation's leadership in the exploration of space and ended the practice of flying astronauts, and a decision against the Shuttle, in his mind, would have done both.[36]



An object lesson in the role of humans in space exploration. Charles Conrad, Jr., Apollo 12 commander, examines the robotic Surveyor III spacecraft during the second extravehicular activity (EVA-2) in 1969. The Lunar Module (LM) *Intrepid* is in the right background. This picture was taken by astronaut Alan L. Bean, Lunar Module pilot. The *Intrepid* landed on the Moon's Ocean of Storms only 600 feet from Surveyor III. The television camera and several other components were taken from Surveyor III and brought back to Earth for scientific analysis. Surveyor III soft-landed on the Moon on 19 April 1967. Interestingly, microbes from Earth on the Surveyor spacecraft survived in hibernation during a three-year stay on the lunar surface and revived upon return to Earth. This suggests the resilience of life in the harsh environment of space. *(NASA JSC photo no. AS12-48-7136)*

35. Caspar W. Weinberger to President Richard M. Nixon, via George Shultz, "Future of NASA," 12 August 1971, White House, Richard M. Nixon, President, 1968–1971 File, NASA Historical Reference Collection, Washington, DC.

36. John Erlichman interview, Washington, DC, by John M. Logsdon, 6 May 1983, NASA Historical Reference Collection, Washington, DC. See also George M. Low, NASA Deputy Administrator, to James C. Fletcher, NASA Administrator, "Items of Interest," 12 August 1971, and James C. Fletcher, NASA Administrator, to Jonathan Rose, Special Assistant to the President, 22 November 1971, both in Fletcher Correspondence, folder 4247, NASA Historical Reference Collection, Washington, DC.

Prestige also played a key role in the decision to build a space station. At a 1 December 1983 meeting in the White House, NASA Administrator James M. Beggs asked President Ronald Reagan to approve his agency's space station plans. Beggs stressed the space station's potential contribution to the leadership of the United States on the world's stage. He knew that Ronald Reagan had long been concerned with a perceived withering of American prestige vis-à-vis the Soviet Union. The station, he argued, would help to quell that declension. But as the punch line for the briefing, Beggs hit Reagan between the eyes with a photo of a Salyut space station overflying the United States. He emphasized that the Soviet Union already had this modest space station and was planning a larger orbital facility. Should not the United States have one as well? Reagan agreed it should.[37]

Prestige will ensure that no matter how difficult the challenges and overbearing the obstacles, the United States will continue to fly humans in space indefinitely. In the aftermath of the *Columbia* accident on 1 February 2003 that took the lives of seven astronauts, when it appeared that all reason for human spaceflight should be questioned, no one seriously considered ending the program. Instead, support for the effort came from all quarters. Even President George W. Bush, who had always been silent on spaceflight before, stepped forward on the day of the accident to say that "the cause in which they died will continue. Mankind is led into the darkness beyond our world by the inspiration of discovery and the longing to understand. Our journey into space will go on."[38]

Of course, there is a positive aspect to this prestige that is very present throughout the age of spaceflight. One might call this pride, which aims to make Americans feel good about what they are doing. There is a genuine excitement and interest in space science/technology that the human spaceflight program produces. This is not new, and it remains critical to understanding this rationale for spaceflight. One might ask, as John Krige recently did, "How many people would come to the National Air and Space Museum [NASM] if it was just the NAM, and why are the human in space objects the ones that attract the most attention?"[39] As Krige asserts, the prestige factor disguises a critical foreign policy component in all of these human spaceflight programs. National leaders supported Apollo, the Space Shuttle, and the space station efforts not on their merits, but on the image they projected. Their initial

37. "Revised Talking Points for the Space Station Presentation to the President and the Cabinet Council," 30 November 1983, with attached "Presentation on Space Station," 1 December 1983, Reagan/NASA Correspondence, folder 12766, NASA Historical Reference Collection, Washington, DC.

38. Statement by President George W. Bush, The Cabinet Room, 2:04 p.m. eastern standard time (EST), 1 February 2003, in Bush, George W., folder 18262, NASA Historical Reference Collection, Washington, DC.

39. John Krige to author, e-mail message, "Space Rationales," 2 February 2005.

and continued support rested on the value they offered not as instruments of science, military prowess, economics, or the like, but on their usefulness as icons mobilized to buttress America's position in the world. Accordingly, despite some truly significant accomplishments, they have been in no small measure symbolic for the majority of those observing them. That is certainly not all bad, and one might say essentially the same thing about the United States' nuclear arsenal during the Cold War. The missiles and strategic bombers served to deter the Soviet Union, offering a symbolic threat more than one in reality since the doomsday scenarios their use would unleash were too devastating to contemplate.[40] Might this be a powerful enough motivation to continue human spaceflight indefinitely?

The fundamental importance of human spaceflight as an instrument of U.S. foreign policy—which is not necessarily identical with national prestige and geopolitics but is closely allied—should not be mislaid in this discussion. It served, and continues to do so, as an instrument for projecting the image of a positive, open, dynamic American society abroad. What of the good will generated by the United States in opening spaceflight to foreign astronauts during the Shuttle era? What about the significance of binding allies more closely to the United States through numerous international efforts ranging from robotic missions to the International Space Station? The foreign policy dimension of international human spaceflight should not be underestimated.

National Security and Military Applications

Another rationale for spaceflight has involved national defense and military space activity. From the beginning, national leaders sought to use space to ensure U.S. security from nuclear holocaust. In October 1951, Wernher von Braun proposed in the pages of *Popular Science* the building of a space station because "the nation which first owns such a bomb-dropping space station might be in a position virtually to control the earth."[41] In 1952, a popular conception of the U.S.-occupied space station showed it as a platform from which to observe the Soviet Union and the rest of the globe in the interest of national security. As the editors of *Collier's* magazine editorialized, "The U.S. must immediately embark on a long-range development program to secure for the West 'space superiority.' If we do not, somebody else will . . . . A ruthless foe established on a space station could actually subjugate the peoples of the world."[42]

40. There has been an enormous amount of historical literature on this subject. See especially Fred Kaplan, *The Wizards of Armageddon* (Stanford, CA: Stanford University Press, 1991); Herman Kahn, *Thinking about the Unthinkable* (New York: Touchstone Books, 1985); Paul S. Boyer, *By the Bomb's Early Light: American Thought and Culture at the Dawn of the Atomic Age* (New York: Pantheon Books, 1985).

41. "Giant Doughnut is Proposed as Space Station," *Popular Science* (October 1951): 120–121.

42. "What Are We Waiting For?" *Collier's* 129 (22 March 1952): 23.

Early in the 1950s, the U.S. military recognized that space represented the new high ground and that they had to control it. Numerous defense officials referred to space as the high seas of the future. The nation that could exploit the potential benefits of this ultimate strategic high ground for military purposes would dominate the rest of the world. The nation's goals for space dominance have revolved since that time around four interrelated strategic issues:

1) Space is a geographic location like air, land, and sea. Any national security capabilities for these other regions must be replicated in space. The Department of Defense, therefore, must control the use of space and defend its military and civil assets from foreign attack.

2) A strong national security presence in space is vital, even during times of peace. Military strategists long have maintained that those nations most successful at controlling the seas are the same nations that tend most to succeed politically and economically. Space is becoming the seas of the future.

3) Space must be dominated during wartime. That requires that the U.S. be prepared to protect U.S. access to space while denying its enemies' access to space. It also means that the U.S. must be capable of exploiting the space regime, especially preferred orbits and missile lanes.

4) National security requires that the United States enhance space resources for a variety of Earth-oriented missions: command, control, communications, and intelligence (C^3I); early warning; weather forecasting; navigation; antisatellite; space-to-ground attack; and missile defense.[43]

The U.S. military also argued for a human capability to fly in space for rapid deployment of troops to hot spots anywhere around the Earth, but they never managed to convince the political leadership of the nation and, despite periodic attempts, never gained a human military mission. The human spaceflight enterprise also gained energy from Cold War rivalries in the 1950s and 1960s as international prestige, translated into American support from nonaligned nations, found an important place in the space policy agenda. Human spaceflight also had a strong military nature during the 1980s, when astronauts from the military services deployed reconnaissance satellites into Earth orbit from the Space Shuttle. A human military presence in space promises to remain a prospect for national security well into the 21st century.[44]

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43. Bryan Johnson, "Political Economy—The Military Use of Space," 14 May 1999, *http://www.suite101.com/article.cfm/political_economy/19993* (accessed 31 December 2004).

44. See Roger D. Launius, *Space Stations: Base Camps to the Stars* (Washington, DC: Smithsonian Books, 2003), pp. 26–35, 114–121.

As it stands, the military has employed space-based and space-transiting resources for more than 40 years. The major systems include the following:

- Ballistic missiles.
- Reconnaissance satellites, both imagery and signals intelligence.
- Navigational satellites, the Global Positioning System.
- Weather and communications satellites.
- Early-warning satellites.
- Ballistic missile defense.

Collectively, these resources have been enormously important in winning the Cold War and ensuring American preeminence at the dawn of the 21st century.[45] No one questions the legitimate role of space resources in the security of the United States. Indeed, the national defense space budget of the United States exceeded NASA's space budget in 1982 and has far outdistanced its spending since that time. In fiscal year 2003, for example, the Department of Defense's spending on space was $19.39 billion, while NASA's space budget was $14.36 billion.[46]

Economic Competitiveness and Satellite Applications

The fourth rationale of economic competitiveness and commercial applications has provided another reason for engaging in spaceflight. Satellite communications is still the only truly commercial space technology to be developed in the more than 45 years since the beginning of the Space Age in 1957. It generates billions of dollars annually in sales of products and services. The first inkling of what this business might look like appeared in the fall of 1945 when a then-obscure RAF electronics officer and member of the British Interplanetary Society, Arthur C. Clarke, wrote a short article in *Wireless World* that described the use of satellites in 24-hour "geosynchronous" orbits some 26,000 miles above the Earth to distribute television programs.[47]

Perhaps the first person to evaluate both the technical and financial possibilities of satellite communications was John R. Pierce of AT&T's Bell Labs. In the mid-1950s, he argued that a communications "mirror" in space would be worth as much as a billion dollars. His estimate was conservative. Following

45. See Everett Carl Dolman, *Astropolitik: Classical Geopolitics in the Space Age* (Portland, OR: Frank Cass Publishers, 2001); M. Mowthorp, "U.S. Military Space Policy, 1945–1992," *Space Policy* 18 (February 2002): 25–36; Roger Handberg, "Review Article: Military Space Policy: Debating the Future," *Astropolitics* 2 (spring 2004): 79–89.

46. *Aeronautics and Space Report of the President, Fiscal Year 2003 Activities* (Washington, DC: NASA NP-2004-17-389-HQ, 2004), p. 139.

47. Arthur C. Clarke, "Extra-Terrestrial Relays: Can Rocket Stations Give World-Wide Radio Coverage?" *Wireless World* (October 1945): 305–308.

Pierce's leadership, in 1960 AT&T filed with the Federal Communications Commission (FCC) for permission to launch a communications satellite as an experiment.[48] This shocked the Kennedy administration, many of whose senior officials believed that AT&T was seeking to extend its telephone monopoly into the "new high ground" of space. They did not approve, and the U.S. government scrambled to implement a new regulatory environment, something that cheered AT&T's telecommunications rivals if not AT&T itself. Accordingly, NASA was directed to enter the fray in developing this new technology, and in 1961, it awarded contracts to RCA and Hughes Aircraft to build communication satellites, Relay and Syncom. Both, government officials believed, would help offset AT&T's technological lead in the field. This policy succeeded. By 1964, two AT&T Telstars, two Relays, and two Syncoms had operated successfully in space and technological "know-how" had been transferred to companies other than AT&T.

At the same time and largely for similar reasons, the Kennedy administration sponsored the Communications Satellite Act of 1962. This law created the Communications Satellite Corporation (COMSAT), with ownership divided 50-50 between the general public and the various telecommunications corporations. Later, COMSAT became the American manager of an emerging global system known as the International Telecommunications Satellite Consortium (INTELSAT) formed on 20 August 1964. On 6 April 1965, COMSAT's first satellite, Early Bird, was launched from Cape Canaveral. Global satellite communications had begun.[49] From a few hundred telephone circuits in 1965, the INTELSAT system rapidly grew to become a massive organization providing millions of telephone circuits. And the costs persistently declined, making the backers of this technology appear geniuses. Whereas customers had paid as much as $10 per minute using older, cable-based technology, the new satellites reduced costs to less than $1 per minute.[50] Even before this time, government officials realized they had a "winner" on their hands. In 1964, NASA Administrator James E. Webb asked his staff, "How did we get so much communication satellite technology for so little money?"[51] His question was not satisfactorily answered by his NASA lieutenants, but space commerce

48. This story is well told in David J. Whalen, *The Origins of Satellite Communications, 1945–1965* (Washington, DC: Smithsonian Institution Press, 2002).

49. See Hugh R. Slotten, "Satellite Communications, Globalization, and the Cold War," *Technology and Culture* 43 (April 2002): 315–360; Whalen, *The Origins of Satellite Communications*; Andrew J. Butrica, ed., *Beyond the Ionosphere: Fifty Years of Satellite Communication* (Washington, DC: NASA SP-4217, 1997); Heather E. Hudson, *Communications Satellites: Their Development and Impact* (New York: Free Press, 1990).

50. David J. Whalen, "Communications Satellites: Making the Global Village Possible," *http://www.hq.nasa.gov/office/pao/History/satcomhistory.html* (accessed 1 January 2005).

51. Paraphrase of Webb's comments at the 22 September 1964 Program Review, referred to in W. A. Radius to ADA/Shapley, 10 December 1965, Thompson papers, NASA Historical Reference Collection, Washington, DC.

has been dominated by satellite communications, and Webb and his successors have ballyhooed it ever since. The sale of all components associated with satellite communications—development, launch, operations—surpassed $100 billion a year in the first part of the 21st century.

There may be other commercially viable space-based industries that will prove lucrative, but they do not yet exist. Many believed that the Landsat Earth remote sensing efforts of the 1970s and since would turn into a commercial activity, but it failed to gain a market despite its significance as a scientific effort. More recently, remote sensing of various types and for a multitude of activities may be on the verge of takeoff, but this remains to be seen. Many observers point to the growth of space-based navigation as another economically viable activity, but they tend to omit the fact that the constellation of satellites—the Global Positioning System (GPS)—is provided gratis by the Department of Defense, and without this critical infrastructure, it is problematic that much commercial activity would be forthcoming.[52]

In recent years, the economic rationale has become stronger and even more explicit as space applications become increasingly central for maintaining United States global economic competitiveness. Ronald Reagan's presidential administration especially emphasized enlarging the role of the private sector, and its priorities have remained in place thereafter. For instance, in the context of space access, the American political right argued an ideology of progress aimed at private development of space-access technology. This led to changes in the government environment, especially regulations that eased authorizations for launch services, and in the encouragement of private rocket-development projects. Such success stories as the Pegasus air-launched booster for small payloads built by Orbital Sciences, Inc., emerged from this cauldron of entrepreneurship. Even such projects as the X-33/VentureStar™, begun in 1995, used a public-private partnership model between NASA and Lockheed Martin, with each contributing to the development of a small suborbital vehicle that could demonstrate the technologies required for an operational SSTO launcher. The X-33 project had an ambitious timetable to fly by 2001, but instead, NASA canceled the program without flying any hardware.[53]

52. Ray A. Williamson and John C. Baker, "Current U.S. Remote Sensing Policies: Opportunities and Challenges," *Space Policy* 20 (May 2004): 109–116; Sameer Kumar and Kevin B. Moore, "The Evolution of Global Positioning System (GPS) Technology," *Journal of Science Education and Technology* 11 (March 2002): 59–80; Irene A. Miller, "GPS and Beyond: How the Aviation Industry is Advancing the Usefulness of GPS," *Quest: The History of Spaceflight Quarterly* 7 (winter 1998): 41–45.

53. Frank Sietzen, "VentureStar Will Need Public Funding," *Space Daily Express*, 16 February 1998, NASA Historical Reference Collection, Washington, DC; Butrica, *Single Stage to Orbit*, pp. 13–28; Leonard David, "NASA Shuts Down X-33, X-34 Programs," *Space.com*, 1 March 2001, *http://www.space.com/missionlaunches/missions/x33_cancel_010301.html* (accessed 28 March 2003); Andrew J. Butrica, "The Quest for Reusability," in *To Reach the High Frontier: A History of U.S. Launch Vehicles*, ed. Roger D. Launius and Dennis R. Jenkins (Lexington: University Press of Kentucky, 2001), pp. 443–469.

One of the key initiatives in this effort for human spaceflight is tourism, a major aspect that envisages hotels in Earth orbit and lunar vacation packages. In 1995, Patrick Collins, Richard Stockmans, and M. Maita undertook a market study on the potential demand for space tourism for the National Aerospace Laboratory in Tokyo, Japan. In the first actual market research of its type, they suggested that space tourism services would be very popular both in North America and Japan, the two leading economies in the world. Overall, 60 percent of the people surveyed "want to visit space for themselves" and were interested in traveling to space for a vacation. Accordingly, the authors found that a market of 1 million passengers per year paying $10,000 per person would generate revenues of $10 billion per year. Thus the market potential of space tourism is somewhat similar to that of the Concorde.[54] Adding fuel to this belief, NASA engineer Barbara Stone opined at a 1996 conference that "studies and surveys world-wide suggest that space tourism has the potential to be the next major space business."[55]

Several futurists believe that by the year 2030, there will be space tourists taking their vacations, albeit exceptionally expensive ones, in low-Earth orbit. Market studies suggest that there are more than 1,000 people per year willing to spend $1 million each for a weekend in space. Even at multimillion-dollar prices, it could become a billion-dollar-per-year business, space economist Patrick Collins believes, and could grow significantly in the future. If the cost of a space vacation dropped to about $25,000 per person, the number of people making the flight would rise to about 700,000 each year, he predicts. This represents a revenue stream of $17.5 billion per year.[56]

The industry is already beginning to see the first space tourists, as Dennis Tito pioneered the way by spending a week in April 2001 on the International Space Station (ISS). In so doing, advocates of space tourism believed that he has challenged and overturned the dominant paradigm of human spaceflight: national control of who flies in space overseen with a heavy hand by NASA and the Russian Space Agency. Dennis Tito's saga began in June 2000 when

54. Patrick Collins, Richard Stockman, and M. Maita, "Demand for Space Tourism in America and Japan, and its Implications for Future Space Activities," AAS (American Astronautical Society) paper no. AAS 95-605, AAS vol. 91, 1995, pp. 601–610. Available online at *http://www.spacefuture.com/archive/demand_for_space_tourism_in_america_and_japan.shtml* (accessed 2 January 2005).

55. Barbara A. Stone, "Space Tourism: The Making of a New Industry" (paper presented at the International Symposium on Space Technology and Science [ISTS], 1996), copy available in NASA Historical Reference Collection, Washington, DC.

56. Patrick Collins, "The Space Tourism Industry in 2030," in *Space 2000: Proceedings of the Seventh International Conference and Exposition on Engineering, Construction, Operations, and Business in Space*, ed. Stewart W. Johnson, Koon Meng Chua, Rodney G. Galloway, and Philip J. Richter (Reston, VA: American Society of Civil Engineers, 2000), pp. 594–603; Roy W. Estess interview, Johnson Space Center Director, Stennis Space Center, MS, 25 June 2002.

he signed a deal with MirCorp to fly aboard a Soyuz rocket to the Russian space station *Mir.* MirCorp acted as Tito's broker with the Russian space firm Energia, which owned both Mir and the rocket that would get Tito into space. While MirCorp had grandiose plans for operating a space station supporting tourists and commercial activities, they failed to obtain the venture capital necessary to make it a reality. Despite these efforts, MirCorp failed to raise enough money to keep Mir in orbit, and the Russians announced in December 2000 that they would deorbit the space station.

This forced Tito to look elsewhere for a trip into space, and he negotiated a deal with the Russians fly aboard a Soyuz rocket to the International Space Station. While the cash-starved Russian Space Agency was happy to make this deal, no one bothered to discuss it with any of the international partners building ISS. A meltdown in public relations ensued, and NASA led the other partners in a rebellion that reached high into the political systems of the United States and Russia. NASA tried to persuade Tito to postpone his flight in February 2001, ostensibly to undergo two months of additional training before flying in October, but really to win time to convince the Russians not to allow Tito to fly to ISS. NASA and the other international partners building ISS argued that this slippage was paramount because of safety considerations on orbit. Ever a cagey gamester, Tito saw the trap and refused. He forced a confrontation with NASA at the gates of Johnson Space Center in March, where he planned to undergo training in preparation for an April 2001 flight. NASA lost that argument and was crucified by space enthusiasts for trying to block access to space for ordinary tourists. The Johnson Space Center acting Director at the time, Roy W. Estess, reflected a year later that he and his staff did not handle the Tito episode well and would have been better off to embrace the effort, as always ensuring the safety of the mission.[57]

With that one incident in Houston, Tito became a cause célèbre among space activists and NASA haters, who viewed him as the vanguard of a new age of space for everyone. Space psychologist Albert A. Harrison summarized the beliefs of many when he opined that "tourism is one of the world's largest industries and Russia's sale of a twenty million-dollar space station ticket to Dennis Tito represents but the first attempt to pry open the door for civilians in space. (Is there an irony that the Russians are the entrepreneurs prying open the door for space tourism while the Americans try to preserve a government monopoly?)"[58] A *Space.com* Web site visitors poll taken in early May 2001—which did not represent a random sample by any means but suggested where

57. Estess interview, 25 June 2002.

58. Albert A. Harrison, "Our Future Beyond Earth," *Space Times: Magazine of the American Astronautical Society* 40 (July–August 2001): 12.

the space enthusiasts came down on the issue—showed that 75 percent of respondents supported Tito's flight, 24 percent believed he should not have flown, and 1 percent were undecided.[59]

Tito would not allow anything or anyone to stand in his way, and many space activists cheered as he thumbed his nose at "big, bad NASA" to take his week-long vacation on the ISS at the end of April 2001. In making his way over the objections of NASA, Tito may have paved the way for other millionaires to follow. South African millionaire Mark Shuttleworth also flew aboard ISS in the fall of 2001, without the rancor of the Tito mission. Others may make similar excursions in the future, either paying their own way or obtaining corporate sponsorships. Space policy analyst Dwayne A. Day does not believe this is the best way to open the space frontier. He wrote, "Now that Tito has flown, it will not be the Earth-shattering precedent that space enthusiasts hoped for . . . . [I]s it any easier for the average citizen to raise $20 million in cash and buy a seat on a Soyuz than it is to get a Ph.D. in engineering and join the astronaut corps? No. Far from opening a frontier, Tito's flight symbolizes just how out of reach space remains for the common person."[60]

The flight of Dennis Tito offers an ambivalent precedent for the opening of spaceflight to the average person. Space tourism seems only a little closer today, even with the ISS, than it did in earlier eras. If there is a way to bring down the cost of access to space, then this dynamic may change, but until then, it does not much matter how many space stations are in orbit. Without a convenient, safe, reliable, and less costly means to reach them, little will change.[61] Once less expensive access to space is attained, an opening of the space frontier may take place in much the same way as the American continental frontier emerged in the 19th century, through a linkage of courage and curiosity with capitalism. As it does so, the role of the government should become less dominant in space. NASA will continue research and development for space systems and carry out far-reaching space science activities. But widespread human spaceflight should become the province of the commercial sector in the first half of the 21st century.

59. "SPACE.com Survey Reveals Strong Public Support for Dennis Tito's Flight," *Space.com*, 7 May 2001, *http://www.space.com/news/tito_poll_010507.html* (accessed 14 August 2002).

60. Ibid.; Dwayne A. Day, "From Astropower to Everyman to Rich Man: The Changing Human Face of Spaceflight," *Space Times: Magazine of the American Astronautical Society* 40 (July–August 2001): 22–23.

61. The issue of space access is critical to opening any part of space to broad usage. See Roger D. Launius and Lori B. Garver, "Between a Rocket and a Hard Place: Episodes in the Evolution of Launch Vehicle Technology," IAA-00-IAA.2.2.02 (paper presented at the 51st International Astronautical Congress, Rio de Janeiro, Brazil, 2–6 October 2000); Roger D. Launius and Dennis R. Jenkins, eds., *To Reach the High Frontier: A History of U.S. Launch Vehicles* (Lexington: University Press of Kentucky, 2002); Howard E. McCurdy, "The Cost of Space Flight," *Space Policy* 10 (November 1994): 277–289; Craig R. Reed, "Factors Affecting U.S. Commercial Space Launch Industry Competitiveness," *Business and Economic History* 27 (fall 1998): 222–236.

In addition to the ISS efforts of Tito and Shuttleworth, to help make space tourism a reality, Peter Diamandis publicly announced the "X Prize" project at a gala dinner in St. Louis, Missouri, on 18 May 1996. Designed to encourage private space investment, the X Prize offered $10 million to the first team that could launch a privately funded space vehicle into a suborbital trajectory twice within a two-week period. It had to be capable of carrying a pilot and two passengers more than 100 kilometers above the Earth. At the kickoff, numerous commentators linked the X Prize to the prospects for space tourism. NASA Administrator Daniel S. Goldin attended this event and said, "I hope my grandson who is 2 years old will be able to go on a trip to a lunar hotel." Of course, in October 2004, Burt Rutan's entry into the X Prize competition, *SpaceShipOne*, successfully claimed the prize. He and his benefactor, Microsoft billionaire Paul Allen, received numerous accolades for this accomplishment, including *Time* magazine's award for "coolest invention" of the year.[62]

Does the success of *SpaceShipOne* signal an opening of a new commercial space market? Brian Berger, writing for *Space.com*, made this observation on 29 December 2004:

> The dream of opening space to the general public was given a tremendous boost in 2004 with SpaceShipOne's prize-winning suborbital jaunt and congressional legislation to help establish a space travel industry in the United States. But even the biggest champions of commercial spaceflight acknowledge that a vital space tourism market is still years from becoming reality.[63]

It remains to be seen whether these efforts signal a new and exciting possibility of future space tourism. There are many questions yet to be answered, ranging from safety to economic viability to legal restrictions. While there have been some interesting developments in the last few years, much has yet to happen before space tourism finds realization; it remains a tantalizing possibility for the first half of the 21st century.

Scientific Discovery and Understanding

Finally, there exists the ideal of the pursuit of abstract scientific knowledge—learning more about the universe to expand the human mind—and pure science and exploration of the unknown will remain an important aspect of spaceflight

62. Chris Taylor and Kristina Dell, "The Sky's the Limit," *Time* (29 November 2004): 62.

63. Brian Berger, "2004: The Year Space Tourism Finally Took Off," *Space.com*, 29 December 2004, *http://www.space.com/spacenews/business_tourism2004_041229.html* (accessed 2 January 2005).

well into the foreseeable future. This goal clearly motivates the scientific probes sent to all of the planets of the solar system save Pluto. It propels a wide range of efforts to explore Mars, Jupiter, and Saturn projected for the early part of the 21st century.[64] It energizes such efforts as the James Webb Space Telescope, which promises to revolutionize our knowledge of the universe through, among other possibilities, the imaging of Earth-like planets around other stars.

And from the beginning, science has been a critical goal in spaceflight. The National Aeronautics and Space Act of 1958 that created the National Aeronautics and Space Administration (NASA) stated that its mandate included "the expansion of human knowledge of phenomena in the atmosphere and space." This idea has continually drawn verbal and fiscal support, but knowledge for its own sake has proven less important than the pursuit of knowledge that enables some practical social or economic payoff.[65]

Even the Apollo missions to the Moon, certainly inaugurated as a Cold War effort to best the Soviet Union and establish the United States as the preeminent world power, succeeded in enhancing scientific understanding.[66] The scientific experiments placed on the Moon and the lunar soil samples returned through Project Apollo have provided grist for scientists' investigations of the solar system ever since. The scientific return was significant, even though the Apollo program did not answer conclusively the age-old questions of lunar origins and evolution. For example, the origin of the Moon is still a subject of considerable scientific debate, but because of the harvest from lunar exploration during the Apollo era, currently the most accepted theory is that the Moon was formed by debris from a massive collision with the young Earth about 4.6 billion years ago. Prior to the study of the Apollo lunar rock and soil samples in the 1970s, however, confusion ruled among scientists about lunar origins as competing schools battled among themselves for dominance of their particular viewpoint in the textbooks. Indeed, determining the Moon's origins became the single most significant scientific objective of Project Apollo.[67]

64. An excellent discussion of all space probes launched to date may be found in Asif A. Siddiqi, *Deep Space Chronicle: A Chronology of Deep Space and Planetary Probes, 1958–2000* (Washington, DC: NASA SP-2002-4524, 2002).

65. John M. Logsdon, moderator, *The Legislative Origins of the National Aeronautics and Space Act of 1958: Proceedings of an Oral History Workshop* (Washington, DC: Monographs in Aerospace History, No. 8, 1998).

66. See W. David Compton, *Where No Man Has Gone Before: A History of Apollo Lunar Exploration Missions* (Washington, DC: NASA SP-4214, 1989); David M. Harland, *Exploring the Moon: The Apollo Expeditions* (Chichester, U.K.: Springer Praxis, 1999); Don E. Wilhelms, *To a Rocky Moon: A Geologist's History of Lunar Exploration* (Tucson: University of Arizona Press, 1993); Paul D. Spudis, *The Once and Future Moon* (Washington, DC: Smithsonian Institution Press, 1996); Donald A. Beattie, *Taking Science to the Moon: Lunar Experiments and the Apollo Program* (Baltimore, MD: Johns Hopkins, 2001).

67. Stephen G. Brush, "Early History of Selenogony," in *Origin of the Moon*, ed. William K. Hartman, Roger J. Phillips, and G. Jeffrey Taylor (Houston, TX: Lunar & Planetary Institute, 1986), pp. 3–15;

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Through a laborious polling of lunar scientists in the mid-1990s, the staff of the Curator for Planetary Materials Office at the Johnson Space Center, Houston, Texas, compiled a list of the top 10 scientific discoveries made as a result of the Apollo expeditions to the Moon. Collectively, they describe the current state of knowledge about this fascinating astronomical artifact.[68] The quest for knowledge about the Moon continues. In the 1990s, more than 60 research laboratories throughout the world continued studies of the Apollo lunar samples. Many analytical technologies, including some that did not exist in 1969–1972, when the Apollo missions returned the lunar samples, were being applied by a new generation of scientists.[69]

In the case of Apollo, and many others both before and since, a linkage between the spirit and need of scientific inquiry and the spirit and need for exploration served as strong synergetic forces for human spaceflight. This synergy arose explicitly in the National Research Council's 2005 study, *Science in NASA's Vision for Space Exploration*. It asserted: "Exploration is a key step in the search for fundamental and systematic understanding of the universe around us. Exploration done properly is a form of science."[70] As commentator David West Reynolds has noted, "Space probes like Voyager, Hubble, and Sojourner can accomplish *space exploration* as well as *space science* when they send back compelling images that can be appreciated by the public. Space science is at its best when it offers new vista along with its valuable data."[71]

The performance of scientific experiments on the Space Shuttle and the science program envisioned for the ISS demonstrate the same positive linkages at the beginning of the 21st century. Without question, the Space Shuttle has served as a significant test bed for scientific inquiry. While the program was not conceptualized as a science effort—rather it was a technology demonstrator and workhorse for space access—it has been used as a platform for all manner

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Stephen G. Brush, "From Bump to Clump: Theories of the Origins of the Solar System, 1900–1960," in *Space Science Comes of Age: Perspectives in the History of the Space Sciences*, ed. Paul A. Hanle and Von D. Chamberlain (Washington, DC: Smithsonian Institution Press, 1981), pp. 78–100; Stephen G. Brush, "A History of Modern Selenogony: Theoretical Origins of the Moon from Capture to Crash, 1955–1984," *Space Science Reviews* 47 (1988): 211–273; Stephen G. Brush, "Nickel for Your Thoughts: Urey and the Origin of the Moon," *Science* 217 (3 September 1982): 891–898.

68. Curator for Planetary Materials, Johnson Space Center, "Top Ten Scientific Discoveries Made During Apollo Exploration of the Moon," 28 October 1996, NASA Historical Reference Collection, Washington, DC.

69. See G. Ryder, "Apollo's Gift: The Moon," *Astronomy* 22 (July 1994): 40–45; G. Jeffrey Taylor, "The Scientific Legacy of Apollo," *Scientific American* 271 (July 1994): 26–33.

70. National Research Council, *Science in NASA's Vision for Space Exploration* (Washington, DC: National Academies Press, 2005), p. 1.

71. David West Reynolds, "Astronauts: Only Exploration Justifies the Cost and Risk," *Space Times: The Magazine of the American Astronautical Society* 42 (November/December 2003): 4–7, quotation from p. 6.

In an instance of irony of the first order, astronaut Dale A. Gardner, having just completed the major portion of his second EVA in three days, holds up a "For Sale" sign during STS-51A in 1984. While he was probably referring to the two satellites, Palapa B-2 and Westar 6, that they retrieved from orbit, the sign speaks volumes about the lack of a compelling rationale for human spaceflight. On-orbit services provided a reason to send humans into space, but it was very much an approach that was not economically viable, as each Shuttle mission was estimated to cost at least $400 million, whereas a normal satellite and launch services cost less than half of that. *(NASA JSC photo no. 51A-104-049)*

of microgravity and space science enterprises. President Nixon, announcing the decision to build the Space Shuttle in 1972, minimized its scientific role. Instead, he argued that it was "the right step for America to take, in moving out from our present beach-head in the sky to achieve a real working presence in space—because the Space Shuttle will give us routine access to space."[72]

Even so, the Space Shuttle has been a useful instrument in the hands of scientists. Each of its more than 100 flights has undertaken some scientific experiments, ranging from the deployment of important space probes to other planets, through the periodic flight of the European-built "Spacelab" science

72. As an example of the scientific activities undertaken on the Shuttle see Kenneth Souza, Guy Etheridge, and Paul X. Callahan, *Life into Space: Space Life Sciences Experiments, Ames Research Center, Kennedy Space Center, 1991–1998* (Washington, DC: NASA SP-2000-534, 2000). On Nixon and the Shuttle decision, see T. A. Heppenheimer, *Space Shuttle Decision, 1965–1972*, vol. 1, *History of the Space Shuttle* (Washington, DC: Smithsonian Institution Press, 2002).

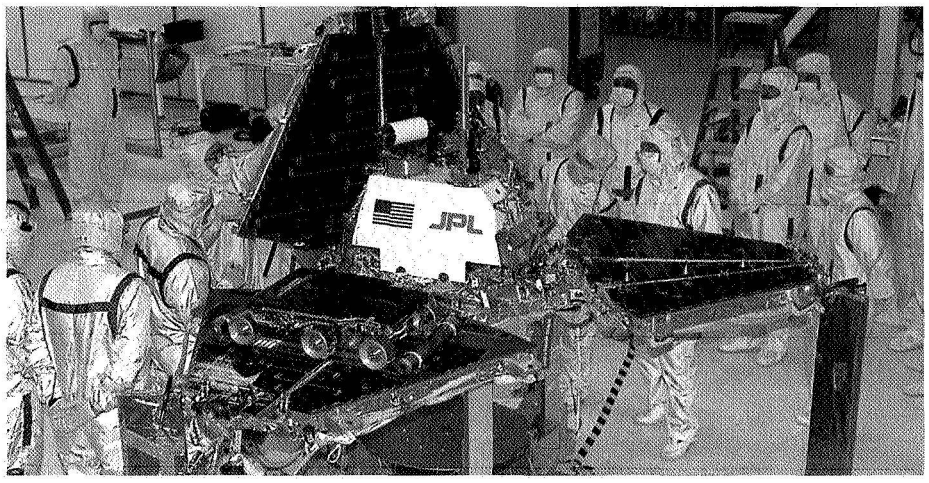
module, to a dramatic set of Earth observations over a 20-year period.[73] One example of a momentous science experiment, among others that might be offered, is the flight of the Italian Tethered Satellite System, designed to investigate new sources of spacecraft power and ways to study Earth's upper atmosphere, on STS-75 in 1996. It demonstrated that tethered systems might be used to generate thrust to compensate for atmospheric drag on orbiting platforms such as the International Space Station. Deploying a tether towards Earth could place movable science platforms in hard-to-study atmospheric zones. Tethers also could be used as antennas to transmit extremely low-frequency signals able to penetrate land and seawater, providing for communications not possible with standard radio. In addition, nonelectrical tethers may be used to generate artificial gravity and to boost payloads to higher orbits.[74]

Of course, some astoundingly significant scientific discoveries have resulted from robotic missions. But, if the purpose of spaceflight is to create a perfect society elsewhere, this necessitates human migration as its core activity. There would be very little reason to limit spaceflight to robotic explorers in this context. Robots might be useful servants—even the modern equivalent of slaves making our lives luxurious—but scientific understanding that might be gained by satellites remote from Earth would be decidedly less important than human spaceflight since the goal is migration. Second, while we seek to migrate into space as a method of ensuring human survival, such a goal is essentially a utopian dream based on expedition myths, and the popular culture treatment of robotics wholly failed to anticipate the degree to which we could send surrogates to do our work. This situation led to specific policy decisions and programs that focused on human spaceflight as the core function of the endeavor.

Many scientists believe that robotic spaceflight is the sine qua non of the Space Age, to the exclusion of a human presence. This is a dichotomy that began with the launch of the first missions into space and has been a perennial debate ever since. If anything, it has grown even more heated as robotic spacecraft have advanced in capability over time. Homer E. Newell, who directed NASA's space science program between 1958 and 1973, commented on this problem during the Apollo program:

73. David Shapland and Michael Rycroft, *Spacelab: Research in Earth Orbit* (Cambridge, England: Cambridge University Press, 1984); Douglas R. Lord, *Spacelab: An International Success Story* (Washington, DC: NASA, 1987); *Science in Orbit: The Shuttle and Spacelab Experience, 1981–1986* (Washington, DC: NASA, 1988); Arturo Russo, *Big Technology, Little Science: The European Use of Spacelab* (Netherlands: European Space Agency [ESA] Publications Division, ESA HSR-19, August 1997); Lorenza Sebesta, *Spacelab in Context* (Netherlands: ESA Publications Division, ESA HSR-21, October 1997).

74. Dennis Papadopoulos, Adam T. Drobot, and Nobie Stone, "The Flight of the Tethered Satellite System," *EOS* 73 (July 1992): 321–323; L. R. O. Storey, "The Shuttle Electrodynamic Tether Mission," *Environmental and Space Electromagnetics* (1991): 37–41.



The most spectacular aspects of space exploration in that last 30 years have been accomplished by robotic probes to other planets of the solar system. Here in the Spacecraft Assembly and Encapsulation Facility-2 (SAEF-2), Jet Propulsion Laboratory workers are closing up the metal "petals" of the Mars Pathfinder lander in 1996. The small Sojourner rover is visible on one of the three petals. On 4 July 1997, Pathfinder soft-landed on the Martian surface and provided spectacular imagery and important scientific data about the red planet's past. Among other findings, scientists learned that Mars had once been a watery planet. *(NASA JPL photo no. 96PC-1130)*

> For space science one of the most difficult problems of leadership, both inside and outside NASA, concerned the manned spaceflight program. Underlying the prevailing discontent in the scientific community regarding this program was a rather general conviction that virtually everything that men could do in the investigation of space, including the moon and planets, automated spacecraft could also do and at much lower cost. This conviction was reinforced by the Apollo program's being primarily engineering in character. Indeed, until after the success of *Apollo 11,* science was the least of Apollo engineers' concerns. Further, the manned project appeared to devour huge sums, only small fractions of which could have greatly enhanced the unmanned space science program.[75]

The scientists viewed the debate over human versus robotic space missions in part as a zero-sum game. The expansive costs of human spaceflight might be

75. Newell, *Beyond the Atmosphere,* p. 290.

more effectively utilized for scientific purposes by sending only robots. They perceived inefficiency, redundancy, and enormous costs to keep astronauts alive as waste, and with only a small percentage of that funding, they believed they could accomplish so much.

The internecine warfare between advocates of human exploration and colonization of regions beyond Earth and the supporters of spaceflight for scientific purposes grew more heated as time passed. Space science leaders such as Homer Newell, Lloyd Berkner, and John E. Naugle established the science element of spaceflight during the 1960s and achieved stunning success in gaining a significant percentage of the NASA budget each year for those activities, usually about 25 to 30 percent. Using that funding, throughout the 1960s they created meaningful missions yielding useful scientific data and, in the process, established a community of scientists dedicated both to NASA and to robotic missions.[76] For example, by 1967, NASA had 942 scientists from 297 institutions involved as investigators in its various science projects. In 1996 alone, it flew 121 experiments on spacecraft and 99 sounding rockets. As Homer Newell reported, "In 1966 we evaluated 366 proposals for flight experiments, 248 of which were selected for flight. An additional 1,329 unsolicited proposals for SR&T work were evaluated."[77] At some level, as these statistics suggest, NASA co-opted some of the opposition to human spaceflight by, in effect, placing scientists on its payroll. Indeed, some NASA officials have expressed anger at University of Iowa astrophysicist James A. Van Allen's persistent criticism of human spaceflight as ungratefulness for all of the space agency's support over the years. One told a group of NASA public affairs officers in 1996 that "NASA made Van Allen, and now all he does is condemn us."[78]

Space science missions remain one of the most visible and popular aspects of the spaceflight agenda. While some of the work requires a human presence, usually to undertake scientific experiments aimed at understanding the biomedical aspects of long-duration spaceflight, most of it is done exceptionally well by robotic explorers. The stunning success of a succession of missions to Mars, as well as to other places, demonstrates this beyond all doubt. No one questions the value of scientific space missions, but many question the necessity of placing humans aboard spacecraft undertaking those scientific efforts.

76. This story is well told in Joseph N. Tatarewicz, *Space Technology & Planetary Astronomy* (Bloomington: Indiana University Press, 1990) and Ronald E. Doel, *Solar System Astronomy in America: Communities, Patronage, and Interdisciplinary Research, 1920–1960* (New York: Cambridge University Press, 1996).

77. NASA Office of Space Science and Applications, "Program Review: Science and Applications Management," 22 June 1967, Space Science and Applications Files, NASA Historical Reference Collection, Washington, DC.

78. Roger Launius witnessed this discussion on 17 October 1998, during a meeting discussing the upcoming flight of John Glenn on STS-95.

HISTORY AND THE SEARCH FOR RELEVANCE

Of the five rationales that may be advanced in support of spaceflight, the human dimension is the only part that is seriously questioned. Military, economic, and scientific efforts in space, many observers have concluded, do not require human missions beyond the Earth. Even though the possibility of a human presence might be desirable in the future—such as in the case of space tourism, certain types of scientific inquiry, and a possible human military presence—thus far, reasons for humans in space to support these activities have remained elusive. Only the human destiny/survival of the species and the national prestige and geopolitics agendas require humans to fly in space. Not all are persuaded by these rationales to expend the considerable resources necessary to continue them. This especially occurred in the aftermath of the *Columbia* accident of 1 February 2003, with the grounding of the Shuttle fleet while an investigation of the cause of the accident took place and the fleet could be retrofitted to overcome the cause of the accident. Initially, NASA leaders promised to return to flight in the fall of 2003. Most observers believed that was unrealistic and possibly motivated by a "can-do" agency's optimism and bravado. Then it slipped into 2004 and finally to the middle 2005 as the Agency's engineers found more and more that needed to be fixed in the aging fleet of orbiters. At the same time, the price tag associated with the Shuttle's return to flight climbed.[79]

The accident called into question long-term assured human access to space. After more than four decades of human spaceflight, this problem is now thornier than ever because of the Shuttle's grounding and compounded every day that the fleet remains inactive. Is the United States as a nation willing to endure a period of several years when humans do not fly in space like we did between the time of the Apollo-Soyuz Test Project in 1975 and the first Shuttle mission in 1981? Are American citizens willing to end human spaceflight altogether? The answer to both of these questions for most Americans is probably "no," but while the support for human spaceflight is broad, it does not seem to be very deep.

Many Americans hold seemingly contradictory attitudes on human space exploration. Most are in favor of the human exploration and development of space and view it as important but also believe that federal money could be well spent on other programs. This relates closely to empirical research on other aspects of public policy. The American public is notorious for its willingness to support programs in principle but to oppose their funding

79. Richard O. Covey et al., "Interim Report: Return to Flight Task Group," 20 January 2004, NASA Historical Reference Collection, Washington, DC.

at levels appropriate to sustain them. Most are also in favor of NASA as an organization but are relatively unfamiliar with the majority of its activities and objectives and sometimes question individual projects. It is a little like how the overlanders traveling to Oregon in the 19th century described the Platte River on the Great Plains: "a mile wide and an inch deep." Americans appreciate and support—in principle—human spaceflight and recognize the astronauts as heroes but believe it is overly expensive. So what do we do for the future? It seems uncertain at present.[80]

Are these sufficient rationales to sustain human spaceflight indefinitely? Only time will tell. The first three rationales have not up to now required a human presence to be effective, but the last two have been used repeatedly to justify an aggressive human spaceflight agenda. The last two rationales—the human destiny/survival of the species and national prestige/geopolitics arguments—have been salient from the beginning of the Space Age. As John M. Logsdon, the dean of space policy, recently wrote:

> Most public justifications for accepting the costs and risks of putting humans in orbit and then sending them away from Earth have stressed motivations such as delivering scientific payoffs, generating economic benefits, developing new technology, motivating students to study science and engineering, and trumpeting the frontier character of the U.S. society. No doubt space exploration does provide these benefits, but even combined, they have added up to a less-than-decisive argument for a sustained commitment to the exploratory enterprise. The United States has committed to keeping humans in space, but since 1972 they have been circling the planet in low-Earth orbit, not exploring the solar system. The principal rationales that have supported the U.S. human spaceflight effort to date have seldom been publicly articulated. And those rationales were developed in the context of the U.S.-Soviet Cold War and may no longer be relevant.[81]

80. Howard E. McCurdy to author, 12 December 2002, copy in possession of author; Roger D. Launius, "Public Opinion Polls and Perceptions of U.S. Human Spaceflight," *Space Policy* 19 (August 2003): 163–175. The best book on the overland migration to Oregon and California remains John D. Unruh, *The Plains Across: The Overland Emigrants and the Trans-Mississippi West, 1840–60* (Urbana: University of Illinois Press, 1979). In it, Unruh describes the overlanders' view of the Platte River: it was something they recognized as necessary but did not enjoy.

81. John M. Logsdon, "A Sustainable Rationale for Human Spaceflight," *Issues in Science and Technology* (winter 2003), available online at *http://www.issues.org/issues/20.2/p_logsdon.html* (accessed 3 August 2004).

Indeed, over time, the traditional arguments have become less powerful as drivers of support for the space program. Since the age of Apollo in the early 1970s, most Americans have taken human spaceflight as a reality that is unchanging but treated the NASA efforts to fly the Space Shuttle and build a space station as necessary rather than desirable. No national commitment to a multibillion-dollar investment for this effort ever took place. Instead, the effort proceeded on inertia not unlike that seen in many other public policy sectors where there is no perceived crisis.